

CLAIMS

What is claimed is:

- 1 1. A method of making a catheter, comprising the steps of:
 - 2 winding a filament onto a core member while rotating the core member relative to
 - 3 a filament source and passing the filament source in a first direction of axial movement
 - 4 relative to the core member; and
 - 5 reversing a direction of axial movement of the filament source while continuing to
 - 6 wind the filament onto the core member, whereby the filament is continuously wound
 - 7 onto the core member to form a first fibrous layer as the filament source is moved relative
 - 8 to the core member from a first axial position to a second axial position and then back to
 - 9 the first axial position.
- 1 2. The method of making a catheter according to claim 1, further comprising the
2 step of anchoring the filament at or near a proximal end of the core member before
3 winding the filament onto the core member.
- 1 3. The method of making a catheter according to claim 2, wherein the filament is
2 wound onto the core member continuously from the proximal end of the core member to
3 a distal end thereof and then back to the proximal end.
- 1 4. The method of making a catheter according to claim 3, wherein the step of
2 winding the filament onto the core member comprises winding the filament with a

3 variable pitch along a length of the core member such that a filament spacing at the distal
4 end of the core member is narrower than a filament spacing at the proximal end of the
5 core member.

1 5. The method of making a catheter according to claim 1, wherein the core
2 member is a mandrel on which the catheter is formed.

1 6. The method of making a catheter according to claim 1, wherein the core
2 member is a substrate that forms an inner lining of the catheter.

1 7. The method of making a catheter according to claim 1, wherein the filament
2 source is a filament spool.

1 8. The method of making a catheter according to claim 1, wherein the step of
2 winding the filament onto the core member comprises winding the filament with a
3 constant pitch along a length of the core member.

1 9. The method of making a catheter according to claim 1, wherein the step of
2 winding the filament onto the core member comprises winding the filament with a varied
3 pitch along a length of the core member.

1 10. The method of making a catheter according to claim 1, further comprising the

2 step of winding at least one additional layer of filament over said first fibrous layer to
3 form at least one additional fibrous layer.

1 11. The method of making a catheter according to claim 10, wherein said step of
2 winding at least one additional layer of filament comprises continuously winding the
3 filament over the first fibrous layer as the filament source is moved axially along the core
4 member from a proximal position to a distal position and then back to the proximal
5 position.

1 12. The method of making a catheter according to claim 11, wherein said
2 proximal position is at a proximal end of the core member and said distal position is
3 between the proximal end and a distal end of the core member.

1 13. The method of making a catheter according to claim 12, wherein said at least
2 one additional fibrous layer comprises a plurality of additional fibrous layers, and wherein
3 said plurality of additional fibrous layers extend to different distal positions along the
4 core member, whereby the first and additional fibrous layers form a catheter having a
5 tapering profile and variable properties along its length.

1 14. The method of making a catheter according to claim 12, further comprising
2 the step of placing a marker band at a distal end of at least one of said fibrous layers.

1 15. The method of making a catheter according to claim 14, wherein said step of
2 placing a marker band comprises placing marker bands at the distal ends of a plurality of
3 said fibrous layers.

1 16. The method of making a catheter according to claim 14, wherein said marker
2 band has a wall thickness approximately equal to a thickness of said distal end of the
3 fibrous layer.

1 17. The method of making a catheter according to claim 1, further comprising the
2 step of coating the core member and fibrous layer with plastic.

1 18. The method of making a catheter according to claim 17, wherein said step of
2 coating with plastic comprises applying a polymer material in a particulate preform over
3 an outer surface of the core member and the fibrous layer.

1 19. The method of making a catheter according to claim 17, wherein said step of
2 coating with plastic comprises laminating a plastic tube over an outer surface of the core
3 member and the fibrous layer.

1 20. The method of making a catheter according to claim 17, wherein said step of
2 coating with plastic comprises extruding a plastic material over an outer surface of the
3 core member and the fibrous layer.

1 21. The method of making a catheter according to claim 17, wherein said step of
2 coating with plastic comprises applying a molecular strand of plastic material over an
3 outer surface of the core member and the fibrous layer using electrostatic forces.

1 22. The method of making a catheter according to claim 1, wherein said step of
2 winding a filament comprises winding a group of filaments simultaneously.

1 23. The method of making a catheter according to claim 22, wherein said group
2 of filaments are wound with a constant spacing between the filaments within the group.

1 24. The method of making a catheter according to claim 22, wherein said group
2 of filaments are wound with a variable pitch such that a filament group spacing at a distal
3 end of the core member is narrower than a filament group spacing at a proximal end of
4 the core member.

1 25. The method of making a catheter according to claim 22, wherein said group
2 of filaments are wound with a variable spacing between the filaments within the group
3 such that a filament spacing at a distal end of the core member is narrower than a filament
4 spacing at a proximal end of the core member.

1 26. The method of making a catheter according to claim 25, wherein said group

2 of filaments are wound with a variable pitch and a variable spacing between the filaments
3 within the filament group.

1 27. The method of making a catheter according to claim 22, further comprising
2 the step of using wire guides to control the filament spacing within the group of
3 filaments, and varying a spacing between the wire guides as the winding proceeds along a
4 length of the core member.

1 28. The method of making a catheter according to claim 22, further comprising
2 the step of providing a guide assembly having a filament engaging surface, and arranging
3 said guide assembly such that the filament engaging surface lies in a plane which is
4 generally perpendicular to a longitudinal axis of the core member, whereby the guide
5 assembly causes the filaments within said group of filaments to be positioned side-by-
6 side and packed tightly against one another as the group of filaments are wound onto the
7 core member.

1 29. The method of making a catheter according to claim 28, further comprising
2 the step of varying a rotation speed of the core member or a translation speed of the
3 filament source along the core member to vary a pitch of the group of filaments being
4 wound onto the core member.

1 30. A method of making a catheter, comprising the step of winding a group of

2 filaments simultaneously onto a core member while rotating the core member relative to a
3 source of said filaments and passing the source of filaments in a first direction of axial
4 movement relative to the core member.

1 31. The method of making a catheter according to claim 30, further comprising
2 the step of varying a rotation speed of the core member or a translation speed of the
3 source of filaments along the core member to vary a pitch of the group of filaments being
4 wound onto the core member.

1 32. The method of making a catheter according to claim 30, wherein said group
2 of filaments are wound with a variable pitch such that a filament group spacing at a distal
3 end of the core member is narrower than a filament group spacing at a proximal end of
4 the core member.

1 33. The method of making a catheter according to claim 30, wherein said group
2 of filaments are wound with a variable spacing between the filaments within the group
3 such that a filament spacing at a distal end of the core member is narrower than a filament
4 spacing at a proximal end of the core member.

1 34. The method of making a catheter according to claim 30, wherein said group
2 of filaments are wound with a variable pitch and a variable spacing between the filaments
3 within the filament group.

1 35. The method of making a catheter according to claim 30, further comprising
2 the step of using wire guides to control the filament spacing within the group of
3 filaments, and varying a spacing between the wire guides as the winding proceeds along a
4 length of the core member.

1 36. The method of making a catheter according to claim 30, further comprising
2 the step of providing a guide assembly having a filament engaging surface, and arranging
3 said guide assembly such that the filament engaging surface lies in a plane which is
4 generally perpendicular to a longitudinal axis of the core member, whereby the guide
5 assembly causes the filaments within said group of filaments to be positioned side-by-
6 side and packed tightly against one another as the group of filaments are wound onto the
7 core member.

1 37. The method of making a catheter according to claim 30, further comprising
2 the step of reversing a direction of axial movement of the source of filaments relative to
3 the core member while continuing to wind the group of filaments onto the core member,
4 whereby the filaments are continuously wound onto the core member as the source of
5 filaments is moved relative to the core member from a first axial position to a second
6 axial position and then back to the first axial position.

1 38. A catheter having a proximal end, a distal end, and a lumen extending
2 between said proximal and distal ends, said catheter comprising:
3 a fibrous reinforcement layer in a wall of said catheter, said fibrous layer
4 comprising a continuous filament having first and second ends and a series of windings
5 formed between said first and second ends, said first end of said filament being anchored
6 in the proximal end of the catheter, said windings extending from the proximal end to the
7 distal end of the catheter and then back to the proximal end, and said second end of said
8 filament being anchored in the proximal end.

1 39. The catheter according to claim 38, further comprising a substrate, and said
2 fibrous reinforcement layer is disposed on an outer surface of said substrate.

1 40. The catheter according to claim 38, further comprising a plastic coating
2 covering said fibrous reinforcement layer.

1 41. The catheter according to claim 38, wherein said windings have a variable
2 pitch along a length of the catheter.

1 42. The catheter according to claim 38, wherein said fibrous reinforcement layer
2 comprises a group of filaments and each filament in said group is a continuous filament
3 with windings extending from the proximal end to the distal end and then back to the
4 proximal end.

1 43. The catheter according to claim 42, wherein a spacing between the filaments
2 in said group of filaments remains constant over a length of the catheter.

1 44. The catheter according to claim 42, wherein said group of filaments has a
2 variable pitch along a length of the catheter.

1 45. The catheter according to claim 42, wherein said group of filaments has a
2 variable pitch and the filaments within said group have a variable spacing between each
3 other along a length of the catheter.

1 46. The catheter according to claim 42, wherein the filaments within said group
2 of filaments are positioned side-by-side and packed tightly against one another in the
3 windings.

1 47. A catheter having a proximal end, a distal end, and a lumen extending
2 between the proximal and distal ends, said catheter comprising:
3 a fibrous reinforcement layer in a wall of said catheter, said fibrous layer
4 comprising a group of filaments which are wound around the lumen between the
5 proximal and distal ends with a variable pitch.

1 48. The catheter according to claim 47, wherein the filaments within said group

2 of filaments have a variable spacing between each other along a length of the catheter.

1 49. The catheter according to claim 47, wherein the filaments within said group
2 of filaments are positioned side-by-side and packed tightly against one another.